PATENT SPECIFICATION

DRAWINGS ATTACHED

Inventors: FREDERICK WARDLE HAYWOOD, JOHN ROSS MACDIARMID and ADRIAN MICHAEL LAWRENCE

1,181,164

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Date of filing Complete Specification: 9 Oct., 1968.

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Index at acceptance: —**B5** A(1R73, 7B, 7C2B); **C3** N(2A1, 10, 12, 25)

PATENTS ACT, 1949

SPECIFICATION NO. 1,181,164

The following corrections were allowed under Section 76 on 9 April 1970.

Page 1, line 46, page 2, line 17 *after* "Molochite," *insert* "(Registered Trade Mark)"

Page 2, lines 25, 58 and 60 *after* "Molochite" *insert* "(Registered Trade Mark)"

THE PATENT OFFICE
1 May 1970

R 123978/16

two basic methods of dewaxing such patterns, namely, dry methods—using dry air, molten wax, etc.—and wet methods, employing steam autoclaves. The various formulations and methods of operation disclosed in the above application are eminently satisfactory for dry methods of dewaxing and also for steam autoclaving, but only for very simple shapes using the latter method.

Further work has shewn that an entirely different approach to the production of such shells gives better performance, particularly on shells for use in the aero-engine and like fields, that is, the largest market for such class of work. This approach is quite different in two main aspects, namely, the chemical approach and the precise method of application of the refractory materials to the wax pattern. In the presently used orthodox method, chemically cleaned wax patterns are dipped in a primary slurry of a given refractory material, e.g. Alumina or Zircon, admixed with either ethyl silicate, hydrosilicic acid or AHY (Aluminium Hydroxychloride) solution and the patterns are then removed and drained and rained with stucco or placed in a fluidized bed—usually a fine powder of say Al_2O_3 or Zircon. The pattern is then gelling with ammonia gas, followed by deammoniating are not used. What we propose is a process for the production of investment casting moulds which comprises feeding particulate stuccos into a high volume low pressure air stream (as defined herein), injecting a liquid capable of gelling the stuccos into the air-entrained stuccos before or after their exit from a surrounding duct and directing the mix thus produced onto wax moulds or patterns to form multiple layers thereupon.

The refractory powder, which is a mixture consisting of different materials and in differing grain sizes for primary and secondary coating, is contained in a suitable hopper, from which the powder passes through a calibrated orifice. The powder is fed or falls by gravity into the blowing tube, and the passage of powder is assisted by means of suitable forms of vibrator attached to the hopper and the tube and also by venturi action of the air. Low pressure air from any suitable source—or induced as in a tube employing the Coanda effect—moves the powder to the exit of the tube.

Either near the exit inside the tube, at the end of the tube, or just outside the tube, the

[*Price 5s. 0d.*]

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International Classification:—**B 22 c 15/24**

COMPLETE SPECIFICATION

Improvements in the Manufacture of Investment Casting Moulds

We, WILD BARFIELD LIMITED, a British company, of Elecfurn Works, Otterspool Way, Watford By-Pass, Watford, Hertfordshire, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

In Patent Specification No. 1,137,738 dated 13th May, 1966, general information is given concerning the manufacture of investment shells on wax patterns. There are two basic methods of dewaxing such patterns, namely, dry methods—using dry air, molten wax, etc.—and wet methods, employing steam autoclaves. The various formulations and methods of operation disclosed in the above application are eminently satisfactory for dry methods of dewaxing and also for steam autoclaving, but only for very simple shapes using the latter method.

Further work has shewn that an entirely different approach to the production of such shells gives better performance, particularly on shells for use in the aero-engine and like fields, that is, the largest market for such class of work. This approach is quite different in two main aspects, namely, the chemical approach and the precise method of application of the refractory materials to the wax pattern. In the presently used orthodox method, chemically cleaned wax patterns are dipped in a primary slurry of a given refractory material, e.g. Alumina or Zircon, admixed with either ethyl silicate, hydrosilicic acid or AHY (Aluminium Hydroxychloride) solution and the patterns are then removed and drained and rained with stucco or placed in a fluidized bed—usually a fine powder of say Al_2O_3 or Zircon. The pattern is then gelled by using ammonia gas in a cabinet, after which it is de-ammoniated. Then the pattern is dipped in a secondary slurry and coated, gelled and the process repeated with sometimes successively larger grains of a refractory material, e.g. Molochite, until a suitable thickness of coating is produced. The pattern is then allowed to air dry for considerable periods before being finally dewaxed.

In our new method which is the basis of this patent application slurries as such and gelling with ammonia gas, followed by deammoniating are not used. What we propose is a process for the production of investment casting moulds which comprises feeding particulate stuccos into a high volume low pressure air stream (as defined herein), injecting a liquid capable of gelling the stuccos into the air-entrained stuccos before or after their exit from a surrounding duct and directing the mix thus produced onto wax moulds or patterns to form multiple layers thereupon.

The refractory powder, which is a mixture consisting of different materials and in differing grain sizes for primary and secondary coating, is contained in a suitable hopper, from which the powder passes through a calibrated orifice. The powder is fed or falls by gravity into the blowing tube, and the passage of powder is assisted by means of suitable forms of vibrator attached to the hopper and the tube and also by venturi action of the air. Low pressure air from any suitable source—or induced as in a tube employing the Coanda effect—moves the powder to the exit of the tube.

Either near the exit inside the tube, at the end of the tube, or just outside the tube, the

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gelling solution is sprayed on to the powder. This solution—which in this case is AHY solution—is fed from an air-spray device working over the range 5—50 p.s.i. The powder now mixed with solution, sprays on to the appropriate wax pattern and coats it with this slurry, which is self-gelling. The actual time of gelling can be controlled within fairly narrow limits.

The wax pattern is first sprayed with the primary slurry, usually a finer grain size material than for the secondary slurry, after which the secondary slurry is applied.

The primary powder may consist of any normal materials presently employed for such coatings, e.g. Alumina, Zircon, Sillimanite or Molochite, to which has been added a solid gelling agent in the form of fine tricalcium penta—aluminate and/or a form of refined gypsum to the extent of 5—20% by weight and/or fine magnesium oxide to the extent of 1—10% by weight.

The secondary powder may consist of any of the normal materials presently employed for such coatings e.g. Molochite to which has been added a solid gelling agent exactly as for the primary coating and in the same proportion as above. In the case of both primary and secondary coatings it is beneficial to add a small percentage 5—20% by weight of ball clay to increase fired strength.

The maximum strength solution which is sprayed on to these powders is a 36% by weight solution of AHY in water.

The low pressure high volume air supply for the propulsion of the powder may be defined as follows:— Flow rates between 2—50 cubic ft. per min. at pressures between 5—50 inches water gauge. The solution of AHY is fed by means of a spray device in such a manner that the solution is atomized. Suitable pressure ranges are 5—50 p.s.i., the preferred range being 5—10 p.s.i.

Typical examples of suitable powder mixes are as follows:—

Primary Coating As mentioned previously the basic material may be Alumina or Zircon, the powder being fairly finely comminuted

Alumina or Zircon	100	parts by weight
Tricalcium penta aluminate and/or refined gypsum	15	„ „ „
Ball clay	15	„ „ „
Pure magnesium oxide	5	„ „ „

The solution is AHY at 36% by weight in water.

Secondary Coating The material currently favoured is Molochite in coarser fractions than for the primary coating:—

Molochite	100 parts by weight
Remainder of solids	As for primary coating

The solution is as for the primary coating.

The advantages of this process over the normal dip slurry and coating methods are as follows:—

There are no slurries with all their attendant difficulties of correct viscosity; constant stirring, to become contaminated and ultimately disposed of due to a short shelf life; slurries as such are not used; gelling by means of ammonia gas cabinets and deammoniating cabinets are not necessary; production is speeded and after the primary coating the secondary coating is completed as one operation; plant required is much simpler and cheaper; labour time is much reduced; the process is free from any explosive risk due to the use of organic materials such as organic-silicates and alcohol; floor space occupied is greatly reduced, hence a much cheaper process and the complete absence of free silica when using AHY as a binding agent.

The basic principles can be applied to all the refractory materials currently employed for the investment of wax patterns.

Apparatus for carrying out the process is illustrated in the accompanying drawings in which:

Fig. 1 is a diagrammatic elevation.

Fig. 2 is a diagram illustrating the principle of a Coanda gun used in the apparatus.

Fig. 3 is a diagrammatic section of a powder feed hopper used in the apparatus.

Air at about 50 p.s.i. is led to the apparatus through an air line 1 from which a branch 2 is led to a gelling solution reservoir 3, and a branch 4 is led to an atomizer mixer 5.

Regulating valve 6 controls air pressure above the surface of the liquid in the reservoir 3, regulating valve 7 controls the pressure of primary air admitted to a Coanda gun 8, while regulating valves 9 and 10 control the admission of air and liquid respectively to the atomizer/mixer 5.

The reservoir 3 is maintained at a desired temperature by a thermostatically controlled electric heating coil 11.

The operating principle of the Coanda gun 8 is shown in Fig. 2; primary air is admitted to an annular chamber 12 through a port 13 and escapes at the mouth of a venturi throat 14 to induce a high volume, low pressure air flow entering at 15.

Stucco powder is fed from a hopper 16, which may be vibrated, by an electrically driven vertical auger 17 in a supply tube 18.

The powder is entrained in the low pressure air flow and is wetted by atomized gelling liquid as it leaves the Coanda gun.

WHAT WE CLAIM IS:—

1. A process for the production of investment casting moulds which comprises feeding particulate stuccos into a high volume low pressure stream (as defined herein), injecting a liquid capable of gelling the stuccos into the air-entrained stuccos before or after their exit from a surrounding duct and directing the mix thus produced onto wax moulds or patterns to form multiple layers thereupon.

2. A process according to claim 1 in which the liquid is Aluminium Hydroxychloride solution.

3. A process according to claim 1 in which the stuccos include tricalcium pentaaluminate.

4. A process according to claim 1 in which the stuccos include refined gypsum to the extent of 5—20% by weight.

5. A process according to claim 1 in which the stuccos include fine magnesium oxide to the extent of 1—10% by weight.

6. A process according to claim 1 in which the stuccos include ball clay to the extent of 5—20% by weight.

7. Apparatus for carrying out the method of claim 1 comprising a pressurised vessel containing gelling solution, an atomizer/mixer fed from said vessel and from an air line, a duct into which stucco powder is fed from a hopper to be entrained in high volume, low pressure air flow and a connection from the atomizer mixer for injecting atomized gelling liquid into the air—entrained stucco powder.

8. Apparatus for carrying out the method of claim 1 constructed and arranged substantially as described herein and shown in the accompanying drawings.

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1181164 COMPLETE SPECIFICATION
1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

FIG.1

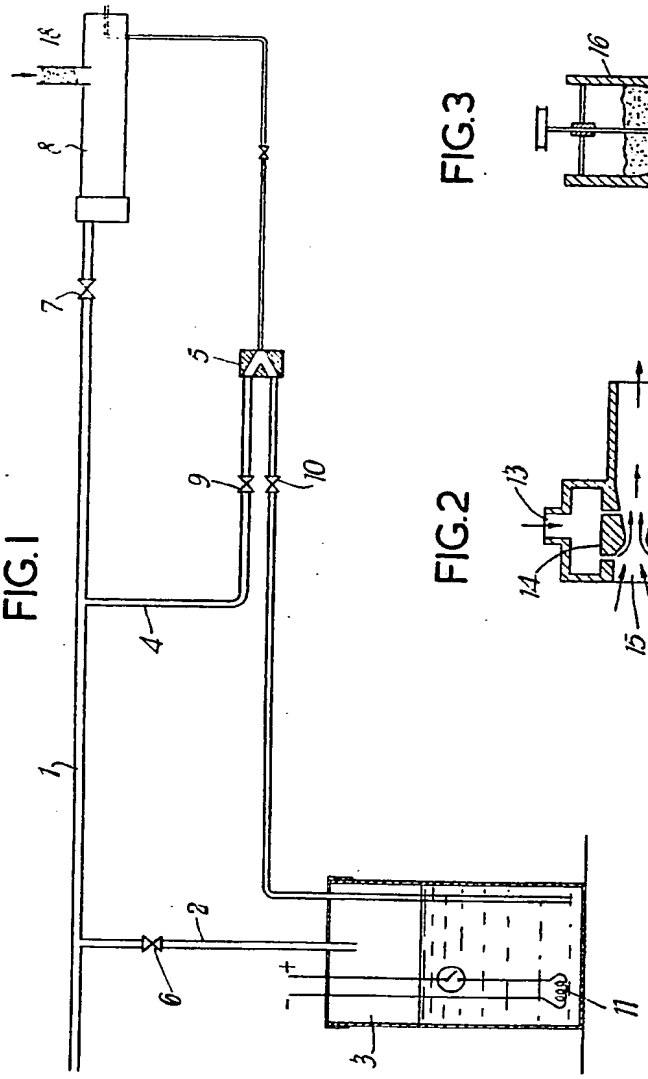

FIG.2

FIG.3